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SUDAN GRASS AS A FORAGE CROP.

By H. N. VINALL, *Agronomist, Office of Forage-Crop Investigations.*

INTRODUCTION.

The discovery of this new hay grass (Sudan grass) came about as the result of a search for forms of wild andropogons which do not have rootstocks. It is acknowledged by agriculturists that Johnson grass, which belongs to this group, would be a valuable hay plant for the Southern States if it were not supplied with aggressive underground stems. Recognizing this fact, an organized search for forms lacking these rootstocks was begun under the direction of Prof. C. V. Piper, in charge of the Office of Forage-Crop Investigations, with the assistance of the Office of Foreign Seed and Plant Introduction. As a result of this effort [1] a grass was obtained under the name garawi on March 16, 1909, from Mr. R. Hewison, Director of Agriculture and Lands of the Sudan Government at Khartum. One-half pound of seed was received, and a portion of this small quantity was planted at the Forage-Crop Field Station, Chillicothe, Tex., that spring. The grass looked very promising there and plans were immediately laid for extending the plantings to other points. In order to give it distinctiveness and assist in its distribution, the name Sudan grass was applied to it.

DESCRIPTION OF SUDAN GRASS.

Under cultivation in the United States, Sudan grass has shown itself to be distinctly an annual. In only two instances under our observation have plants lived over winter—at Gainesville, Fla., and

[1] Piper, C. V. Sudan grass, a new drought-resistant hay plant. U. S. Department of Agriculture, Bureau of Plant Industry Circular 125, 1913.

Oakley, R. A. Some new grasses for the South. *In* Yearbook, Department of Agriculture, for 1912, pp. 499–504.

NOTE.—Demands for information regarding this new hay plant have come from nearly every section of the United States, but more especially from the Southern States, where the need of a desirable hay grass has been acute since the advent of the boll weevil forced diversification of crops. This bulletin is designed to meet this demand by making available the information at hand.

Bard, Cal., both places being practically frost free. This grass is very closely related to the cultivated sorghums and hybridizes with them readily. The fact that it has no rootstocks places it nearer the cultivated sorghums than is Johnson grass, which for many years has been credited by some botanists with being the wild prototype of the sorghums.

FIG. 1.—A typical plant of Sudan grass, showing erect growth, leafiness, and stooling habit. Grown in cultivated rows at Arlington farm, Virginia, 1913.

Sudan grass when seeded broadcast or in drills averages about 3 to 5 feet in height and has stems a little smaller than a lead pencil, being about three-sixteenths of an inch in diameter. If grown in rows and cultivated it reaches a height of 6 to 9 feet, and the stems are larger than usual, being about one-fourth of an inch in diameter. (See fig. 1.) The panicle is loose and open, very much like that of Johnson grass, but a little larger and a trifle more compact. The hulls, or glumes, are awned and when in flower often purplish in color. This color usually fades to a light yellow when ripe. The awns are broken off in thrashing, so that the commercial seed rarely has awns. The leaves are broader and more numerous than those of Johnson grass, giving the grass a much more favorable appearance as a hay plant. The most important difference, however, is that the aggressive underground stems, or rootstocks, with which Johnson

grass is equipped, are entirely absent in Sudan grass. This striking difference is shown clearly in the accompanying figure illustrating

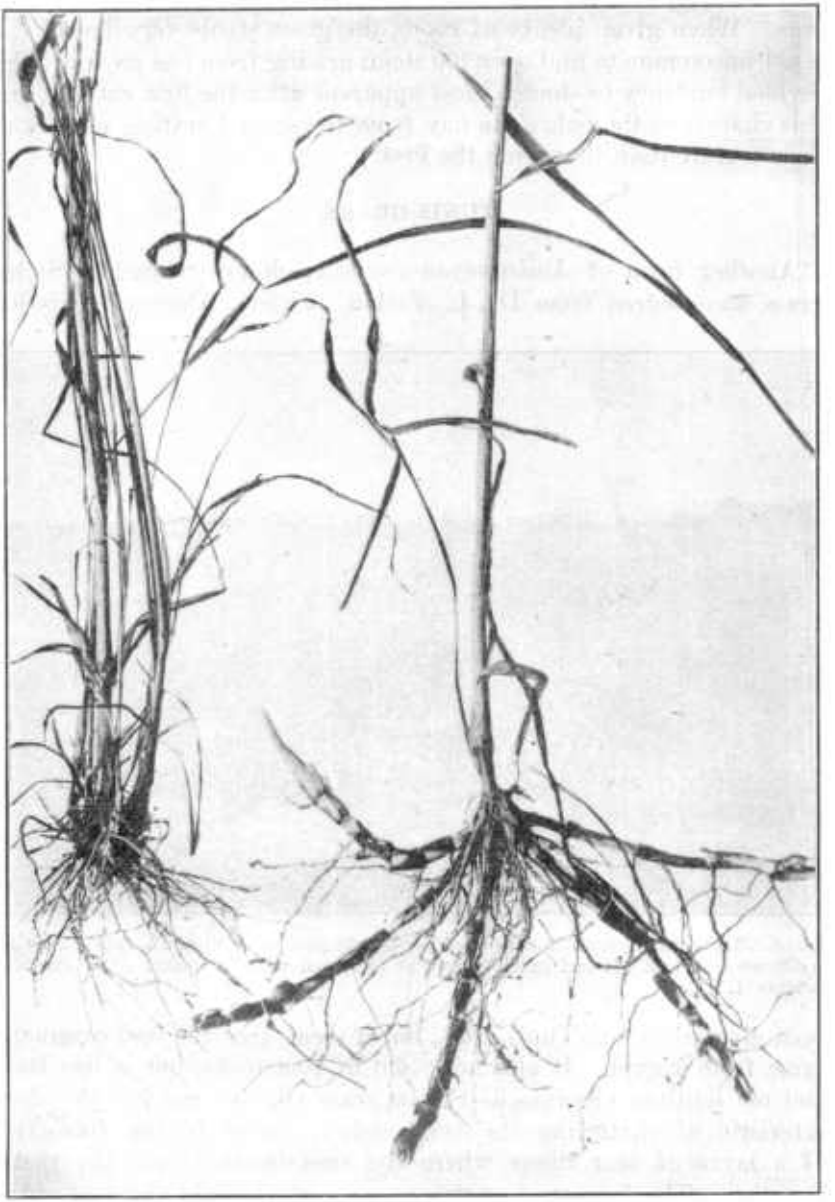

FIG. 2.—Young plants of Sudan grass (left) and Johnson grass (right), showing the vigorous rootstocks of Johnson grass and their entire absence on Sudan grass.

young seedling plants of the two grasses (fig. 2). Sudan grass, like the cultivated sorghums, never develops anything but fibrous

roots, therefore it can not become an obnoxious weed comparable to the perennial Johnson grass. Furthermore, it has shown no tendency to persist in fields as an annual weed through volunteer seedings. When given plenty of room, the grass stools very freely. It is not uncommon to find over 100 stems arising from one crown. This decided tendency to stool is most apparent after the first cutting, and this characteristic makes the hay from the second cutting usually of finer texture than that from the first.

TUNIS GRASS.

Another form of *Andropogon sorghum* closely related to Sudan grass was secured from Dr. L. Trabut, Algiers, Algeria. This has

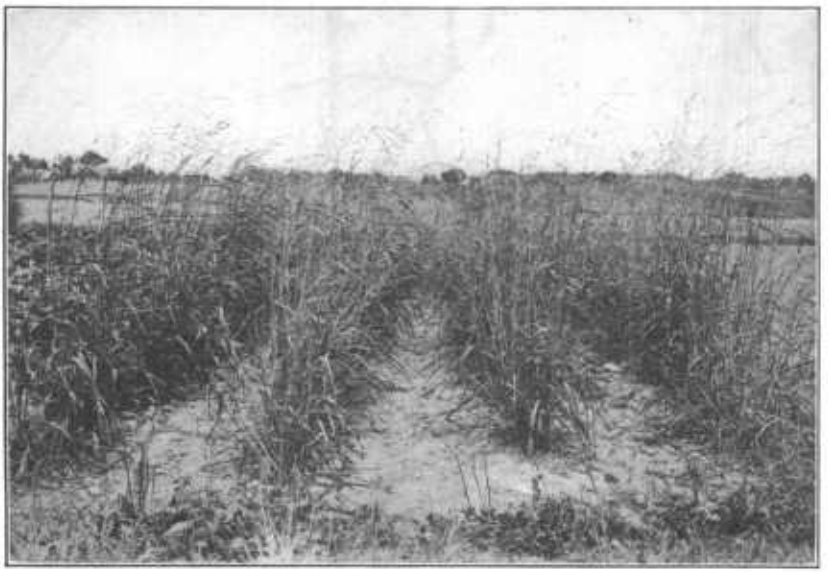

FIG. 3.—Tunis grass grown in cultivated rows, Arlington farm, Virginia, 1912. Note the difference in leafiness and general vigor as compared with the Sudan grass shown in figure 1.

been given the name Tunis grass, but it seems that the seed originally came from Egypt. It also is devoid of rootstocks, but is less leafy and not quite so vigorous as Sudan grass (fig. 3) and has the characteristic of shattering its seed readily, owing to the formation of a layer of scar tissue where the seed breaks from the rachis branches. The formation of this tissue at the base of the seed causes the seed to fall, in the same way that the production of the leaf scar on trees in the autumn starts the shedding of leaves. In most cases Tunis grass will lose practically all its seed while the leaves are yet green. So far there seems to be no place in the United States where it is superior or even equal to Sudan grass.

CLIMATIC REQUIREMENTS OF SUDAN GRASS.

Sudan grass, like other sorghums, does best in a warm climate. In favorable seasons, where the growing period is long, as many as four cuttings can be obtained in one year. As is the case with all other crops, in determining the regions of greatest importance climatic and soil conditions are linked with the acuteness of the need for such a crop. For example, in the present instance Sudan grass promises to become of most importance throughout Texas, in western Oklahoma, western Kansas, western Nebraska, and central South Dakota, as illustrated by region 1 of the map shown as figure 4. This is not because it makes better yields here than in region 4, but because there

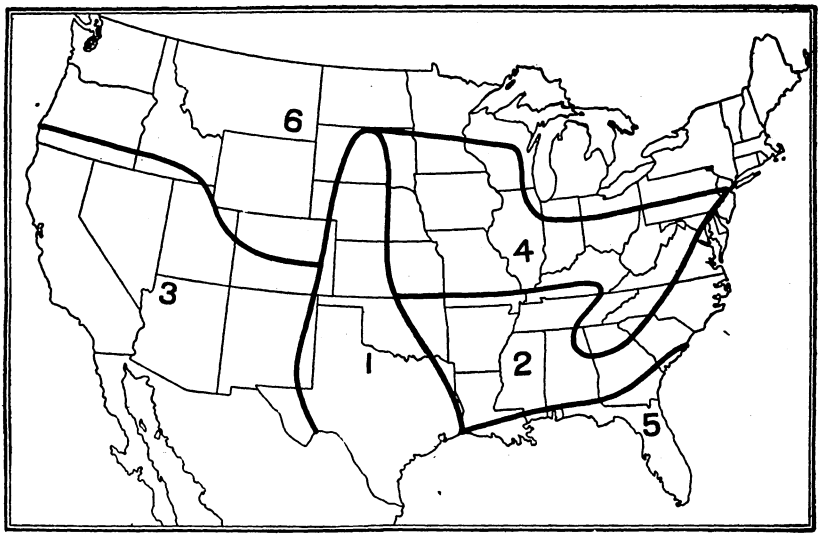

FIG. 4.—Map of the United States, showing the regions to which Sudan grass is more or less well adapted and also those where its production is regarded as impracticable. 1, The region in which Sudan grass promises to be of most value and in which it is expected to become the most important hay grass; 2, apparently almost as valuable here as in region 1, though the data are as yet inconclusive; 3, produces abundantly under irrigation, and the grass seems destined to become second only to alfalfa as a hay crop; 4, recommended only as a substitute for millet in its use as a catch crop or for growing in situations where neither timothy nor alfalfa succeed well; 5, results in this region are unfavorable; 6, not of any considerable value, the region being too cool for the proper development of the grass.

has been found no other satisfactory hay plant, generally speaking, for region 1, while in region 4 timothy, clover, and alfalfa all do well and there is no strong demand for another hay plant. Region 1 extends north to the south line of North Dakota, because in the central Great Plains the summers are sufficiently warm and long enough to mature one cutting, and in some cases two cuttings of Sudan grass, thus giving this region a hay of good quality to replace the millets. At Brookings, S. Dak., it has done well for two years, making hay yields much in excess of those produced by millet and matur-

ing abundant crops of seed. In the southern part of the United States, designated on the map as region 2, the climatic conditions are also favorable to the production of this grass, but there are found there several other grasses and legumes which partially fill the need for a hay crop. The results of tests in this region have been quite favorable, but sufficient data have not been obtained to warrant recommending the use of Sudan grass as the principal hay crop. In the southwestern part of the United States, included in region 3 on the map, Sudan grass will no doubt be extensively grown under irrigation, since the yields of both hay and seed have been highly satisfactory. Its value in alfalfa-growing communities will no doubt depend very largely on its ability to furnish a change of feed without loss of tonnage.

It is likely that Sudan grass will supersede the millets as catch crops in most of the region east of the Rocky Mountains, south of the southern boundary of New York, and north of Tennessee. (See region 4, fig. 4.) The yield from one cutting in this region is not apt to exceed that of German millet, but if handled properly two cuttings can be obtained in many cases, and the quality of the hay is much superior to that of millet hay. Near the Gulf coast the humid atmosphere and continuous heat favor the development of the red-spot disease (sorghum blight) and thus reduce the yield. (See region 5, fig. 4.) This is true to some extent also on the Atlantic coast of the Southeastern States.

Continued cool weather, such as one encounters in high altitudes, is detrimental to the growth of Sudan grass. This fact precludes its successful production in the intermountain section, including most of Wyoming and Montana and considerable of Utah, Colorado, Idaho, Oregon, and Washington. (See region 6, fig. 4.) Results in these States have for the most part been unfavorable. At Burns, Oreg., the yields of Sudan grass varied from 350 to 500 pounds per acre. At the State experiment station, Corvallis, Oreg., it was reported as of much less value for hay than vetch and oats. At Moro, Oreg., the yield was 1,780 pounds per acre, but even there it was doubtful whether it would supersede grain hay. At Adams, in Umatilla County, Oreg., it did poorly also. At Walla Walla, Wash., when seeded at the same time and under the same conditions as alfalfa, it made less growth, although alfalfa is usually slow in starting. At Laramie, Wyo., with an altitude of 7,188 feet, it made only 6 inches of growth.

SOIL REQUIREMENTS.

Sudan grass is not at all exacting in its soil requirements. It does best on a rich loam, but it has been grown successfully on almost every class of soil from a heavy clay to a light sand. Where

the soil is quite sandy, however, the yield may be expected to be light. To do well, the ground must be fairly well drained.

DROUGHT ENDURANCE.

The value of Sudan grass under conditions of extreme drought has not been definitely established. Reports from those testing it do not agree on this point. Reports from the South, where lack of moisture has been combined with extreme heat, have in general been favorable to this grass in comparison with millets and sorghums. Farther north most of the reports indicate that, grown under extreme drought conditions, it produces less than millet. It may be that high temperature, which is known to be necessary to the best development of the grass, is the deciding factor. During 1913, when the drought was especially severe in the central Great Plains region, direct comparisons of Sudan grass and millet indicated that the latter is capable of making better yields under such conditions.

The following extract from a letter of Joseph E. Maxwell, superintendent of the Kaibab Indian School, Moccasin, Ariz., is interesting, as showing the evident difference in the relative behavior of Sudan grass farther south:

> All the sorghum planted this year was a failure on account of the extreme drought early in the season. No moisture fell to wet the ground from early in March until July 18, and then the ground was wet to the depth of only about 3 inches. * * * The Sudan grass was planted on May 15, while the ground was quite dry. * * * The Kafir corn and other sorghum planted in the same field died out, but the Sudan grass kept growing through the dry weather.

A photograph accompanying Mr. Maxwell's letter shows the grass to have reached a height of over 5 feet. Confirming this report are the experiences of F. J. McCarthy, Boerne, Tex., J. R. Stegall, Detroit, Tex., and others, recorded on pages 17 to 20 of Circular 125 of the Bureau of Plant Industry.

It is possible that Sudan grass may not produce as much hay per acre as the millets under exceptionally unfavorable conditions, but in ordinary years it will yield two cuttings and will, like other sorghums, stand semidormant through a period of drought, and if rain comes before the end of the growing season it will immediately renew its growth. In very few instances have millets been known to do this. It is believed, therefore, that during a term of 12 or 15 years, even considering the whole Great Plains region, Sudan grass will outyield millet.

CULTURE.

PREPARATION OF THE SEED BED.

In seeding Sudan grass a rather firm seed bed is best. Usually, when it is desired to drill the seed, the ground is plowed in the spring

and harrowed down well, as for corn. A cool soil delays the germination of the seed; hence, spring plowing is preferable for the seed bed, because it assists in warming the soil. No fertilizers are necessary in the West, where the soil is reasonably good, but in the East it is probably advisable to use some complete fertilizer, such as is applied for corn. No experiments, however, have been carried out to determine the best practice to follow.

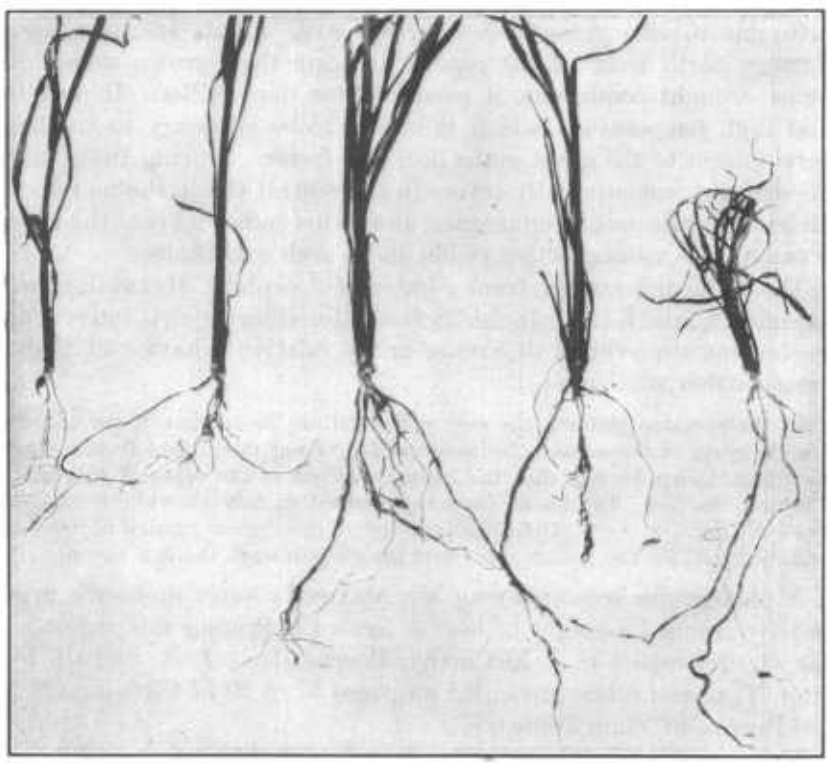

FIG. 5.—Sudan-grass seedlings, showing the effect of planting at different depths. From left to right the plants are from seeds sown, respectively, ½ inch, ¾ inch, 1½ inches, 2 inches, and 3 inches deep.

DATE OF SEEDING.

It has been found best to seed Sudan grass after the soil has become warm, about corn-planting time or a little earlier. When sown in cold soil the result is usually a poor stand or slow growth for several months, so that in the end no advantage has accrued from the early seeding.

Widely scattered experiments have shown that in very few cases are the earliest seedings highest in yield. The experience so far gained by the Department of Agriculture in its tests indicates that for the extreme South the best time for seeding lies between April

1 and 15; farther north, in the latitude of Oklahoma and Kansas, April 15 to May 15 is most profitable; and north of that, in the latitude of Nebraska and South Dakota, May 1 to June 1 has given the best results.

METHOD OF SEEDING.

In regions of abundant rainfall, for hay production the best machine for seeding is no doubt the common grain drill. Well-cleaned seed feeds freely from this drill, and it can be distributed evenly and a good stand thus secured. If a press drill is used, the ground is left level and in good condition for the mower. The depth of seeding has but little effect on the root system of Sudan grass. It seems to be a characteristic of the grass that the root

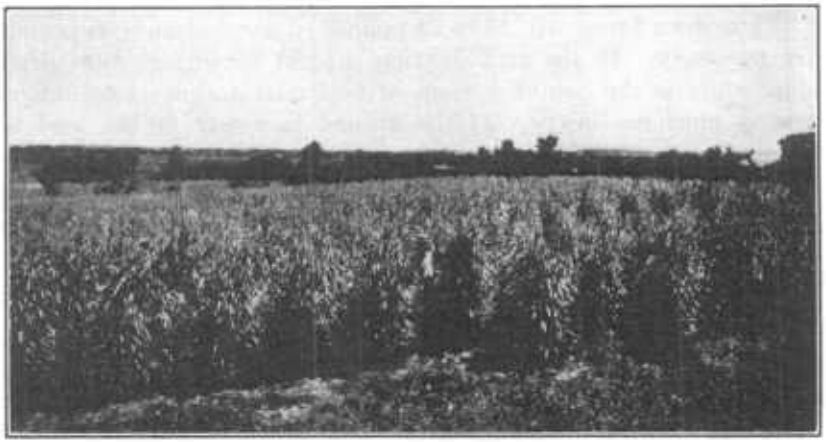

FIG. 6.—Sudan grass grown in 42-inch rows for seed production, on the farm of R. E. Thompson, Stillwater, Okla.

system begins near the surface of the soil, regardless of the depth at which the seed is placed. (See fig. 5.) The best depth, everything considered, is from one-half to 1 inch, but where the soil does not become packed the plant will force itself to the surface even from a depth of 3½ to 4 inches.

In the semiarid regions for hay, and in any locality for seed production, better results are obtained by seeding it in rows far enough apart to allow cultivation. This can be accomplished with the grain drill by stopping up a sufficient number of the holes so that the rows seeded will be the desired distance apart. Where only the ordinary corn cultivators are available for the work it is best to place the rows 36 to 42 inches apart. (See fig. 6.) If a beet cultivator or some similar tool is available, larger yields can be obtained from rows 18 to 24 inches apart. The latter distance (24 inches) is perhaps

as close as practicable, unless horses especially trained to walk between the rows are to be had. If such is not the case, much of the stand will be destroyed by trampling. It has been found in carefully planned experiments that the cultivated-row plantings are apt to give the larger yields under irrigation. Against this difference in favor of the cultivated-row planting over the broadcasted field will have to be charged the cost of cultivation. There is also in many cases a better quality of hay produced from the broadcast stand, owing to the finer stems. The grass grown in cultivated rows is apt to be coarse and therefore not so desirable for market hay. For home feeding the coarseness will be of little disadvantage, as the stems do not become so woody that they are refused by stock.

RATE OF SEEDING.

When sown broadcast, 16 to 24 pounds of good clean seed per acre are necessary. In the arid districts a light seeding is most profitable, while in the humid sections or under irrigation 24 pounds per acre is none too heavy. If the ground is weedy or the seed bed poorly prepared, 30 pounds is better. For seeding in cultivated rows 36 to 44 inches apart, 2 to 4 pounds of seed per acre will be found sufficient, while in rows 18 to 24 inches apart, 4 to 6 pounds per acre will be required, the less quantity being used, as in the broadcast seedings, for regions of light rainfall. When a seed crop is desired, the rate of seeding should ordinarily be somewhat less than for a hay crop.

SUDAN-GRASS AND LEGUME MIXTURES.

The suitability of Sudan grass for growing in mixtures with cowpeas, soy beans, and other legumes is at once apparent, for several reasons. Sudan grass grows strictly erect, with a stem stiff enough to support the vines characteristic of most legumes, and it thus makes the harvesting easier by keeping the legumes off the ground. It also allows them to cure more quickly by preventing the leaves from matting. It is low in protein, which is prominent in legumes, and thus a well-balanced mixture is produced. The yields, although they are not often as great as that of Sudan grass alone, are so large that little forage weight is lost by the intermixture of legumes, and the feeding value of the hay is considerably enhanced.

The yields obtained from such a mixture in 1913 varied from 1 to 3½ tons per acre. The best showing was made at the Maryland experiment station, where the yields averaged about 3¼ tons of cured hay per acre. In 1912, at Arlington farm, Virginia, the mixture of Sudan grass and cowpeas gave a yield of 4.6 tons of cured hay per acre, while Johnson grass in mixture with the same variety of cow-

peas made a yield of only 2.8 tons per acre. (See fig. 7.) Sudan grass in mixture with soy beans the same year made a yield of 4.4 tons per acre.

HARVESTING.

The most common way of harvesting the grass for hay is with a mower. It cures readily and can be cut in the morning and raked up that afternoon or the next day if the sun is bright. After bunching, it is placed in cocks, similar to millet, and removed from these cocks to the barn or stacks after it has thoroughly cured. The leaves are retained well, and if it has been cut at the right stage of maturity and handled properly it will make a bright, leafy, sweet hay of the

FIG. 7.—Plats at Arlington farm, Virginia, in 1912, showing mixtures of Sudan grass and cowpeas (right) and Johnson grass and cowpeas (left).

very best quality. Where the crop is desired for seed, it is harvested like the small grains with an ordinary grain binder and allowed to cure in shocks. This method can also be used in making hay in the semiarid regions where good drying weather prevails, so that the grass will cure in the shock.

Where the planting is made in cultivated rows, a corn or row binder can be used, but in a majority of cases a grain binder is preferable. In some cases, where the growth is rank, trouble is experienced in getting the reel over the tops of the plants and at the same time cutting a short stubble. The time for cutting is governed to some extent by the fact that several cuttings are expected in most cases, and this makes it most profitable to cut the

first time as early as possible, so that the grass will have more time for growth. Sudan grass makes the best quality of hay if cut after full bloom, and when there remains no chance for an additional cutting the hay will be improved by waiting until this stage of maturity is reached. When cut for seed, the first heads should be fully ripe, as the stools will ripen somewhat later than the main stem and there is little loss from shattering.

There are very few hay grasses which are injured so little by standing beyond the proper stage of maturity as Sudan grass. This is due largely to the numerous stools, which, arising from the base, mature successively later than the main stem and always furnish immature stalks, even when the main stem has ripened. There is, in addition, the fact that most of the sorghums hold their leaves well and make the best quality of fodder when the seed has reached the dough stage. This characteristic makes it possible, where necessary, to extend the haying process over a long period without any material loss either in the quantity or quality of the hay. Such a feature is of great importance to the farmer, since the cutting time for his hay often comes when he is rushed with other work, or his haying may be interfered with by rains and thus prevent him from cutting at the most favorable time.

ROTATIONS.

Sudan grass, being an annual, can be fitted into any rotation without much trouble. Very little benefit to the soil will result from growing it, however, as it is a rank feeder and leaves nothing in the soil for improvement except the decaying roots. It can perform no such office as the legumes, which are known to benefit the soil by the addition of nitrogen through nodules on the roots. It will, however, furnish hay and afford a change in crop, which usually benefits the soil.

UTILIZATION.

HAY.

As stated previously, the hay from Sudan grass is of first-class quality and the yields are quite satisfactory, so that the grass will no doubt be most largely utilized as a hay crop. From the central United States southward it will be possible to get two cuttings, and in favorable instances as many as four cuttings have been secured. From seeding to the first cutting 75 to 80 days are necessary. The second cutting comes on about 45 days after the first one, and the third one is likely to take a little longer—50 to 55 days. This means that the growing season must extend over a period of six months to get three cuttings. By cutting the grass a little earlier each time four cuttings can be obtained in the same period. This was done

at Chillicothe, Tex., in 1912. A plat was seeded April 26 and the following cuttings obtained:

Date.	Yield per acre.	Growing period.
	Pounds.	*Days.*
June 22	2,140	57
July 17	1,810	25
August 20	3,050	34
October 14	1,800	55
Total	8,800	171

It is quite probable that an equally large yield of hay of better quality would have been obtained from three cuttings, as this would have given time for each cutting to reach the proper stage of maturity. In 1913, when conditions were unusually severe in the Great Plains region, the following hay yields in tons per acre were recorded for Sudan grass when it was sown at the most favorable time: In western and central South Dakota, 1¼ to 2 tons; eastern South Dakota and southern Minnesota, 4¾ to 5 tons; eastern Colorado and northern Texas, 1½ to 2¼ tons; in the eastern United States (Maryland and Virginia), 2¼ to 3¾ tons; and farther south (Tennessee, Mississippi, Louisiana, and Florida), 2 to 5½ tons.

These yields were all made without irrigation. When irrigated, the yields compared favorably with those of alfalfa, as shown in the following pages. In a few localities millet has given a slightly larger crop than Sudan grass, but comparisons between these two crops have been based on one cutting only. When the very much better quality of the Sudan-grass hay and the probability of two or more cuttings are taken into account there is little doubt that Sudan grass will eventually replace the millets as the most widely used catch crop.

FEEDING VALUE.

That Sudan grass is palatable has been demonstrated on numerous occasions, but so far no feeding experiments have been carried out to determine its digestibility. It has been reported by farmers, however, that cattle have done well when fed on the hay. Numerous analyses of the grass have shown it to be about the same in chemical composition as Johnson grass and timothy hay. The percentage of protein decreases from the heading period until the seed is ripe, but the value of the grass for hay is no doubt as great about blossoming time as at any previous stage. This comes from the increase in yield as well as the improvement in digestibility. Nearly all immature forage is inclined to be laxative and probably does not remain in the digestive tract sufficiently long to permit the complete assimilation of the food elements.

VALUE IN IRRIGATED SECTIONS.

In many of the irrigated sections of the West, where alfalfa is the principal crop and dairying the chief industry of the people, alfalfa has been made the constant and the almost complete diet of the cows. The continuous use of this high-protein hay has caused digestive troubles, and this derangement of the digestive functions seems to disappear promptly when the feed is changed. In such sections south of Oregon and Wyoming, Sudan grass would make an excellent crop to grow for mixing with the alfalfa. Yields of cured hay obtained under irrigation the past year in California and Arizona have been equal and in some cases superior to those from alfalfa. At Chico, Cal., Sudan grass when irrigated gave a yield of 9.8 tons of cured hay per acre against a yield of 8.3 tons of alfalfa hay; at Bard, Cal., in the extreme southern end of the State, Sudan grass on favorable soil gave a yield of 8 tons of hay per acre against a yield of 7.9 tons of alfalfa. The yield of 8 tons at this place was made notwithstanding the fact that the grass was planted almost a month later than it should have been. At Phoenix, Ariz., the yield of Sudan grass was 7.8 tons per acre, as compared with a yield of 9.8 tons of alfalfa, and at Owens, Ariz., it made a yield of 4.5 tons per acre with only one irrigation during the season.

These unusual yields of hay from an annual crop which by its nature can be made to fit into any rotation will no doubt mean much to the dairying industry of the Southwest.

The percentage of moisture is apt to be somewhat greater in Sudan grass than in the alfalfa when the weights are taken directly from the field, but there is less labor necessary to handle the Sudan grass because the maximum yield from it will be secured in three cuttings, while with the alfalfa five or more cuttings will be required to produce the yields mentioned.

This is the first grass yet found which will yield under irrigation in the Southwest even approximately as much as alfalfa. It can be used, therefore, in providing a change of feed without any loss in the tonnage obtained from the land. It has appeared just in time to solve this problem which only in the last two or three years has become acute and for which dairymen have just begun to clamor for a solution. Sudan grass is not as rich in protein as alfalfa, but when mixed with alfalfa or fed with some concentrate rich in protein the limited experience indicates that the flow of milk will be nearly or quite normal.

SOILING AND SILAGE.

Sudan grass is suited admirably for use as a soiling crop, since it makes a large yield and is very palatable in the green state as well

as when cured for hay. Enormous yields are secured under irrigation, because the growth is so rapid and the recovery from cutting so prompt. A small area in the South, where the rainfall is adequate or where irrigation is possible, can be made to support a goodly number of animals by this method.

No trial of Sudan grass as silage has as yet been carried out, but judging from its palatability and its succulence it would be excellent for this purpose, especially in mixtures with legumes. A mixture of Sudan grass and cowpeas or soy beans could be grown for silage as well as for hay. Its use for silage will no doubt be very limited, owing to the ease of making it into hay and the fact that there is little waste in feeding it.

PASTURE.

No pasture tests have yet been completed, but Sudan grass seems to lack several of the essentials of a good pasture: First, it is an annual and the ground would necessarily be soft and considerable injury from trampling would result, since it does not form a turf; second, live stock pasturing on it would, no doubt, pull out quite a number of plants; and finally, being a sorghum, it may, in some cases, be a carrier of prussic acid, which is quickly fatal to cattle when occurring in considerable quantity.

SEED PRODUCTION.

Probably in no other feature is Sudan grass any nearer perfect than in its seed habits. It produces seed freely in a loose, open panicle, which is carried well up by the stem, so that it can be harvested easily. The seed is retained well, and thus the loss from shattering is much less than in other wild forms of sorghums. The seed does not break from the rachis with a scar, but carries a portion of the rachis branch with it. Fields have been left standing long after the seed was ripe, and except for that eaten by birds little was lost.

Harvesting is accomplished most economically with an ordinary grain binder. When the seed is practically mature, Sudan grass can be cut and bound like grain and left to cure in shocks. It may then be hauled directly to the thrashing machine or stacked in the same manner as grain. The thrashing machine used for wheat and other small grain will thrash and clean the seed perfectly if it is well matured when harvested. If cut too early the seed will be chaffy, and there is likely to be some loss from being blown over in the straw when it is thrashed.

A clover huller has also been used in some cases with success. Seed thrashed in a clover huller is apt to be more thoroughly freed

from the glumes than when thrashed in a grain thrasher. The weight of the seed varies from 30 to 40 pounds per bushel, but good seed will weigh about 40 pounds to the bushel and can be seeded without trouble through the ordinary type of grain drill. The yields are such that seed growing at present prices is extremely profitable. The following yields per acre of cleaned seed were obtained mostly from small plats, but they are indicative of what may be expected under favorable conditions: In Virginia, 450 to 500 pounds; Ohio, 800 pounds; Minnesota and eastern South Dakota, 800 to 1,400 pounds; eastern Colorado and northern Oklahoma, 400 pounds; northwestern Texas, 550 to 650 pounds; southern Texas,

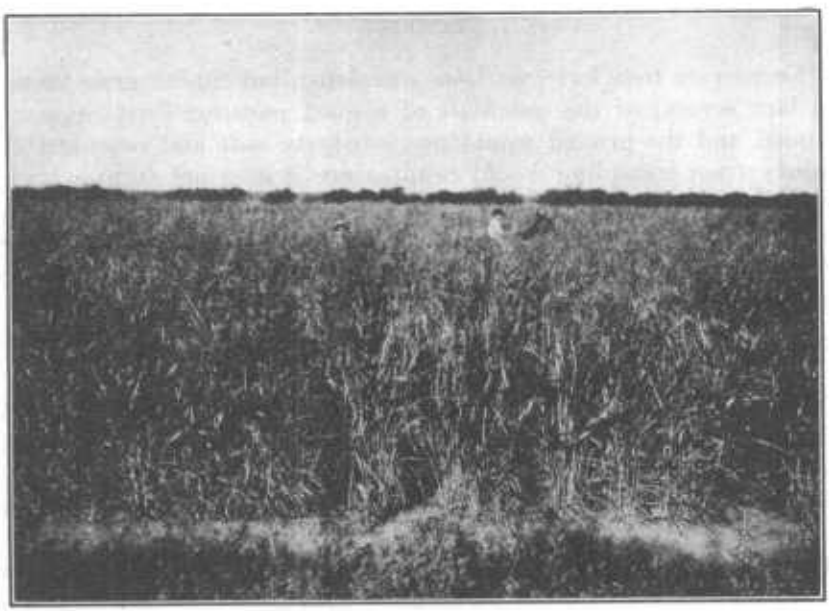

FIG. 8.—A field of Sudan grass on the farm of J. C. Burns, Lubbock, Tex., in 1913. This field yielded over 500 pounds of clean seed per acre without irrigation.

900 pounds. Under irrigation the yield per acre at Rocky Ford, Colo., was 1,600 pounds; at Davis, Cal., 1,150 pounds; at Chico, Cal., 1,200 pounds; and at Phoenix, Ariz., 2,250 pounds.

The best seed yields of Sudan grass may be expected in the West, where warm, dry weather prevails. (See fig. 8.) Owing to the unusual success of this grass in 1912 and 1913, the price of seed has become excessively high. During the winter of 1913–14 seedsmen asked $1.50 to $2.25 per pound for the seed, and farmers sold it in quantity for 50 cents to $1.50 a pound. These prices can not long continue, as the grass seeds so abundantly.

The seed of Sudan grass resembles Johnson grass very closely, except that it is larger and more plump. It is only through a critical

examination that they can be distinguished (fig. 9), and this fact emphasizes the importance of growing the two grasses separately. The adulteration of Sudan-grass seed would be an easy matter, but the chief danger doubtless lies in accidental admixture through the production of seed on fields infested with Johnson grass. To avoid this it would be advisable when the seed becomes abundant to use only

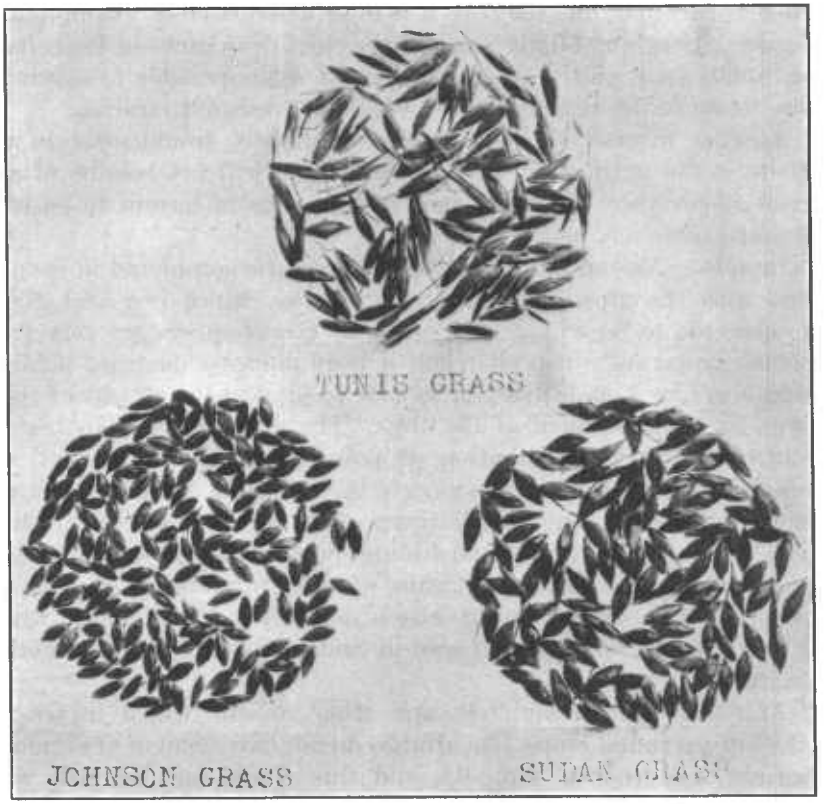

FIG. 9.—Seeds of Tunis grass, Johnson grass, and Sudan grass. (Natural size.) Note the difference in size between the seed of Johnson grass and of Sudan grass.

that produced in the North beyond the Johnson-grass area. It is likely that in time, as the demand becomes more permanent and the farmers are educated to ask for seed from a section of the country known to be free from Johnson grass, there will be definite areas devoted to Sudan-grass seed production, just as there are regions devoted to the production of German millet and Kentucky bluegrass seed. Within a few years the price of seed will no doubt be reduced to 4 or 5 cents a pound.

ENEMIES.

Diseases.—The worst disease that so far has developed is the so-called sorghum blight,[1] more appropriately designated as red-spot. This disease is characterized by the appearance of distinct reddish spots or blotches on the leaves, these spots gradually spreading until the leaves turn brown and die. Its effect on the plant is much the same as rust and, like the rust, it is most destructive in warm, humid regions. Sorghum blight is one of the chief drawbacks to the culture of Sudan grass on the Gulf coast, but it seems possible to overcome this weakness by the production of disease-resistant strains.

Another disease which is apt to be slightly troublesome in the South is the grain smut of sorghum. This will not become of any great importance, however, since Sudan grass is certain to be used almost exclusively as a hay crop.

Insects.—Among the insects which are to be considered in connection with the growing of Sudan grass the chinch bug and grasshoppers are so far of most importance. Grasshoppers are very fond of this grass, and when abundant will do immense damage. Chinch bugs also like it, and little can be done to prevent the attacks of these pests by any treatment of the crop. The grasshoppers can best be controlled by the distribution of poisoned bran baits around the edges of the field, while the chinch bugs may be destroyed in their winter quarters through the burning of the bunch-grass and trash in which they usually are found hiding, or their access to the Sudan-grass field is prevented by means of dust furrows, ditches, or oil barriers. The sorghum midge also is destructive in the South, where it prevents the formation of seed in Sudan grass, as it does in other sorghums.

Animals.—Moles, squirrels, and other rodents which injure the stand of perennial crops, like alfalfa, do not harm Sudan grass much, because it is resown annually, and this places such animals at a disadvantage.

Weeds.—No serious weed pests interfere with the production of Sudan grass, for the same reason that animals are of minor importance, as the annual cultivation of the soil destroys all but annual weeds and the grass grows so rapidly that such weeds are not likely to crowd it out.

BREEDING.

The Sudan grass imported from Africa seemed quite free from impurities and very uniform in growth, so that in the original crop

[1] Kellerman, W. A., and Swingle, W. T. Sorghum blight. *In* First Annual Report, Kansas Agricultural Experiment Station (1888), pp. 281–302.

Burrill, Thomas J. A disease of broom-corn and sorghum. *In* Proceedings, Society for the Promotion of Agricultural Science (1887), Eighth Annual Meeting, pp. 30–36.

Radais, Maxime. On the blight of sorghum. *In* Botanical Gazette, vol. 28, no. 1 (1899), pp. 65–68.

there was but little room for selection. The second and third year, however, it began to show signs of having crossed quite freely with the sorghums, and in these hybrid plants and their progeny there is sufficient variation to satisfy any breeder. (See fig. 10.) Some decidedly promising silage and soiling types have appeared in the progeny, and these are being watched and propagated with the idea of developing strains adapted to special conditions and uses. It is doubtful whether any improvement will be made in the original grass as a hay type; therefore it is important that this original type should be maintained in a pure state. Its fine stems and splendid stooling characteristics make the quality of the hay better than that

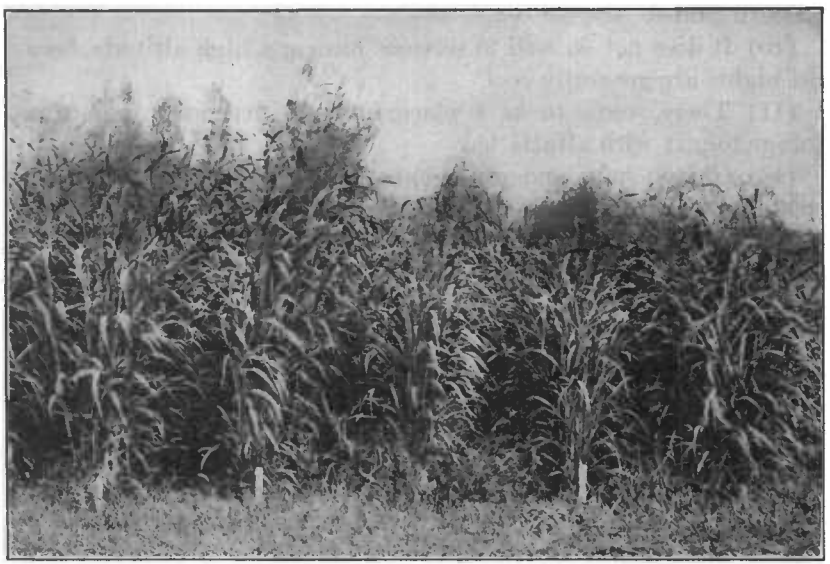

FIG. 10.—Rows of Sudan grass-sorghum hybrids, Arlington farm, Virginia, in 1912 (left); typical Sudan grass on the right.

from the sorghum-Sudan grass hybrids. One field of improvement which looks promising is that of resistance to disease. A number of the hybrid progeny grown at Arlington farm, Virginia, in 1913 were very much more resistant to the red-spot than others. These are being developed, in the hope that a strain which can endure the humid and warm atmosphere of the Gulf coast will be obtained.

SUMMARY.

(1) Sudan grass is closely related to the cultivated sorghums and is thought by some to be the progenitor of this group.

(2) It was obtained from Khartum, Sudan, in 1909.

(3) In appearance it is similar to Johnson grass, but it is somewhat more erect, taller, and has a broader leaf.

(4) It lacks entirely the underground rootstocks which make Johnson grass a pest.

(5) Two or three cuttings can be obtained from it under favorable conditions.

(6) The yields vary from 1 to 8 tons of cured hay per acre.

(7) Its seed habits are good, and large returns are now being secured from the seed produced.

(8) The seed of Sudan grass resembles very closely that of Johnson grass; therefore farmers should use seed only from regions free from Johnson grass.

(9) It promises to fill a long-felt want for a hay grass in the South, and will likely replace millets as a catch crop in the Central and Eastern States.

(10) It does not do well in sections having a high altitude, because the nights are generally cool.

(11) There seems to be a place for it in irrigated regions as a forage to mix with alfalfa hay.

(12) Chinch bugs and grasshoppers, among insects, and the red-spot disease are its greatest enemies.

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